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T.W.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

LANG et al.

Serial No. 09/852,616

Art Unit: 3617

Filed: May 11, 2001

Examiner: Ajay Vasudeva

For: LOW-DRAG HYDRODYNAMIC SURFACES

SUPPLEMENTAL RESPONSE

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GROUP 3600

To the Director of the Patent and Trademark Office

Sir:

In further response to the office action dated August 16, 2002, kindly replace pages 10 and 11 of the Response filed November 18, 2002 with the attached pages 10 and 11.

On page 10, the words "Logic then dictates that" have been moved from the fourth line from the bottom to the beginning of the sentence starting on the second line from the bottom.

On page 11, line 10, "following" has been replaced by "above".

Reconsideration and allowance are requested.

Respectfully,

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"Local" is known to refer to angle of attack at a particular point.

"Saw-tooth-like" does not fall within MPEP 2173.05(d), which deals with "such as" or "for example."

"The body has a yaw angle" is acceptable. Yaw is known to be the angle from straight ahead.

"Sides that deviate from side lines" correctly describes the structure.

Reconsideration and allowance of claims other than accepted Claims 74-78 is requested. Claims 1-61, 125-142 and 152-174 describe an important new invention that is not included in Lang '829. The present invention is described in the claims. This new invention further reduces drag on a hydrofoil with closed cavities by minimizing, or approximately minimizing, a cavity contact angle. The cavity contact angle is minimized in a desired cavity closure region to increase cavity area. For example, if cavity area coverage on a hydrofoil is increased from 75% to 87% by using this new idea, frictional drag is reduced by about a factor of $7.7 = 1/(1-0.87)$, instead of a factor of $4.0 = 1/(1-0.75)$.

This new invention seems simple, but is not, and requires a non-typical design approach. For example, a typical design approach would be to make the cavity contact angle exactly zero at a desired cavity closure point. Unfortunately, the cavity would not close at the desired point and would instead close well ahead of this point. This result occurs for the following reasons.

As one might expect, tests show that cavity length typically increases as a gas flow rate increases. Tests also show that the gas flow rate increases with cavity contact angle. If a surface is shaped so that, for example, a desired minimum cavity contact angle lies midway between stations A and B where the cavity contact angle is larger by 4 degrees, logic then dictates that as a gas flow rate increases, a cavity will eventually close at station A, but will then jump to station B

as the gas flow rate further increases. The cavity will avoid closure at the desired cavity closure station because the gas flow rate is too large to permit the cavity to remain at this station. There is a simple solution to this problem.

To minimize a cavity closure angle at a desired closure point, the surface ahead of the desired closure point should be designed so that cavity length increases with gas flow rate until the desired cavity closure point is reached. If done optimally, the cavity closure angle is minimized at the desired cavity closure point. Beyond this closure point, cavity closure angles should be designed to increase in order to provide a design margin in gas flow rate before the cavity reaches the trailing edge.

The inclusion of this new invention distinguishes the above claims from Lang '829: Claims 62-73 contain a new invention that reduces the wetted surface of a hydrofoil nosepiece and smoothes the walls of an upper cavity to further reduce the drag of a hydrofoil with closed cavities. In its simplest form, this new invention has a flat plate nosepiece inclined at a large angle to the water flow, such as 60 degrees. It is described as a wetted nose section on the lower surface that extends from the leading edge rearward to a span-wise lower discontinuity. This causes a lower boundary layer to separate from the lower surface and form a lower cavity extending rearward along the lower surface. The nose section has an upper surface discontinuity causing an upper water boundary layer to separate from the upper surface of the hydrofoil and form an upper cavity rearward, extending along the upper surface. Such a plate cuts the wetted surface area of a nosepiece in half or more.

Claims 79-100 describe a new invention that relates to a surface-piercing strut or hull that includes a horizontal fence to separate an upper superventilated cavity from a lower closed cavity.